PROC. ENTOMOL. SOC. WASH.
99(3), 1997, pp. 537–540

MORPHOLOGICAL CHARACTERISTICS OF THE STING AND PREY CARRIAGE MECHANISM IN *SERICOPHORUS RELUCENS* F. SMITH (HYMENOPTERA: SPHECIDAE: LARRINAE)

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Abstract.—Morphological characteristics of the sting concerning prey carriage in *Sericophorus relucens* F. Smith are described. The sting apparatus consists of sting palpi (with bristles), stylet, and lancets, with different morphological adaptations. Correlation between the morphological features of some parts of the sting and their function in prey carriage are discussed.

Key Words: *Sericophorus relucens* F. Smith, Sphecidae, prey carriage, sting morphology

There are basically three types of prey carriage in the Sphecidae: mandibular, pedal, and abdominal, each with several subtypes. The most primitive one is mandibular (found in the majority of Sphecidae species), and the more advanced are pedal (found in four groups of this family) and abdominal (found in three groups of this family) (Evans 1962). The abdominal type of prey transport includes three subtypes: abdominal transport with the use of a specially modified apical abdominal segment, "buprestid clamp" subtype, a modification of the fifth abdominal sternum, and abdominal transport with the use of the sting.

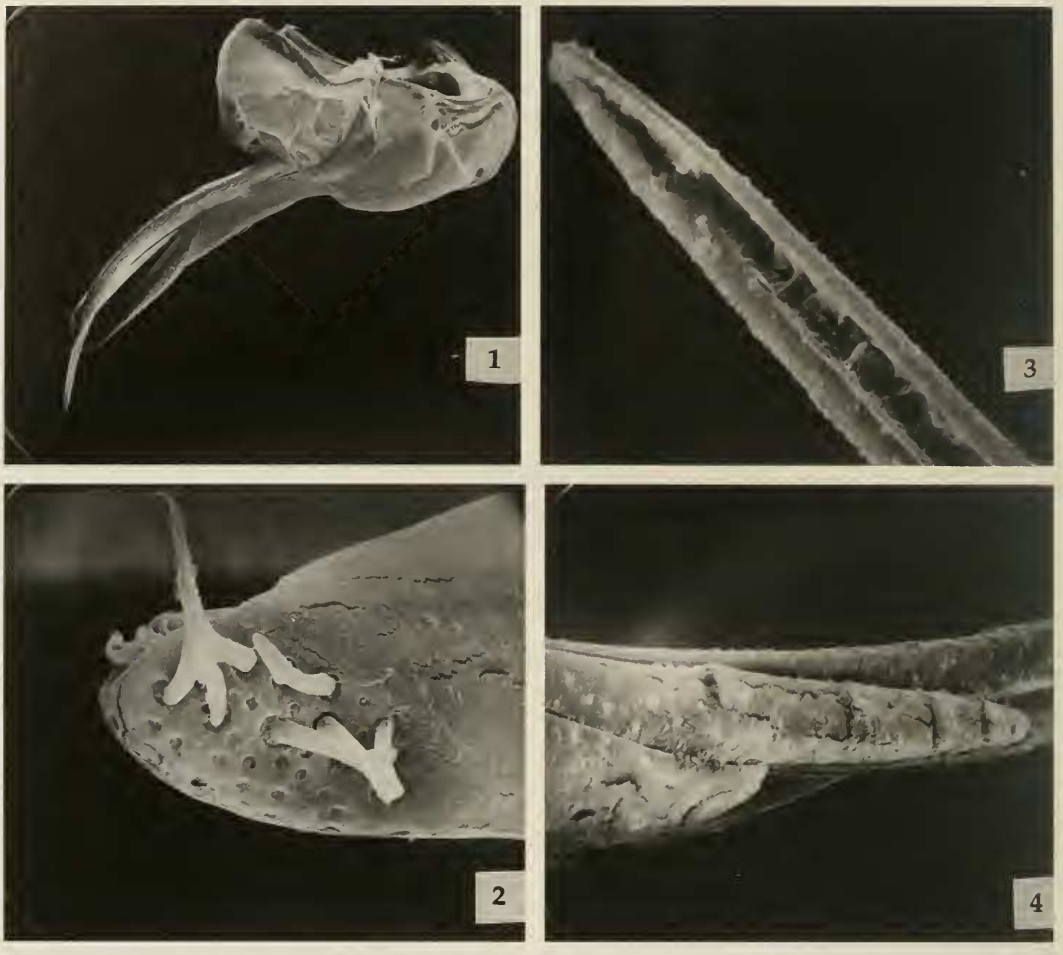
The first subtype is found in *Listropygia* and *Clypeadon* (Philanthinae), and is characterized by a modified apical abdominal segment in the form of a clamp (Evans 1962; Bohart and Menke 1976).

The second subtype is found in certain *Cerceris* species (Krombein 1981).

The third subtype is found in some Crabroninae (*Oxybelus* sp., *Crossocerus* sp.) (Evans 1962) and in *Sericophorus relucens* F. Smith (Larrinae) (McCorquodale 1988). McCorquodale (1988) first reported sting prey carriage in a species outside the Crabroninae, *S. relucens,* the first found in Larrinae which is one of the most advanced prey transport mechanisms.

Most of the Sphecidae that use their sting apparatus for prey transport exhibit some adaptive changes in the morphology of several structures of the sting, mainly the stylet, that are correlated to sclerotisation and mobility of their prey (Radovic 1985). Those changes in general are a curved stylet in sphecids that prey on fast flying insects; a slightly curved or straight stylet in those praying on slower insects. The presence of bristles on the distal part of palpi and presence of barbs on the distal part of lancets function in securing prey impaled on the stylet.

Sericophorus relucens preys upon Diptera (Matthews and Evans 1970; Peckham and Hook 1980). They sting their prey in the air, on the ventral side of the thorax, and keep it impaled on the sting, not removing it while flying, till they get to the nest (McCorquodale 1988).



Figs. 1–4. *Sericophorus relucens.* 1, Lateral view of the sting apparatus (SEM, 65×) (original). 2, Tip of the palpus (SEM 100×) (original). 3, Tip of the stylet (SEM, 100×) (original). 4, Lancet barbs positioned in lancet tracks (SEM, 100×) (original).

Materials and Methods

We examined five specimens obtained from Dr. O. Lomholdt (Zoologisk Museum, Copenhagen), from Blue Mountains and Kurrajong, New South Wales; Mount Wedge and Mundiwindi, Western Australia.

The sting apparatuses (Fig. 1) were first removed from the abdomen of the specimens, and initially preserved in glycerol. They were cleaned for scanning electron microscopy (SEM) by soaking in 1:1 solution of ammonium hydroxide and water, dehydrated in ethanol, soaked in chloroform, and air dried. We fixed them to the SEM stubs using silver conducting paint. A "sputter coater" was used for gold coating the objects (Gibson 1984). The stings were filmed using "Foma" (5 × 5 cm) film.

Results

Examining five specimens of *S. relucens,* we found the following elements of the sting apparatus:

1. Sting palpi.—Two sting palpi consisting of two segments are present (Fig. 1). Several (commonly around ten) bristles are found on the tip of the distal part (Fig. 2). Bristles are distributed along the horizontal axis of the palpus tip forming two groups: longer bristles (on the distal part of the tip)

and shorter bristles (on the sides of the tip). The bristles are unsegmented, rough surfaced, straight with slightly enlarged base. Similar bristles are found on the side of the proximal segment of the palpi.

2. Stylet.—The stylet (Fig. 3) is long and curved (less than in *Oxybelus* species) with a sharp pointed tip. The surface and edges of the stylet are rough, covered with tubercles, and different in shape and size. The lancet tracks, concavely shaped with no special structures (like olistheter scales or setae found in Vespidae, Ondricek-Fallscheer 1992), are located on the ventral side of the stylet, and covered with larger tubercles. The cracklike poison duct is located near the tip of the stylet.

3. Lancets.—A pair of lancets is located on the ventral side of the stylet. We found unexserted lancets in all of the examined specimens. Lancets are sharply pointed and covered with small tubercles. Similar to some crabronine sphecids, the lancets of *S. relucens* are barbed (Fig. 4). Six barbs are positioned on the dorsal side and form a line parallel to the longitudinal axis of the lancet. The barbs differ in size: those closer to the lancet's tip have smaller dimensions in contrast to those with proximal position that are particularly wider at their base. No variation was found in the number of barbs between the two lancets and among different specimens. Sensilla campaniformia were not noted.

Discussion

Regarding morphological and behavioral characteristics, the type of prey carriage found in *S. relucens* belongs to the abdominal "sting" type that is found only in two other genera of Sphecidae and is considered to be one of the most advanced (Evans 1962).

Most of the features of the sting apparatus examined in our research show correlation between their morphological characteristics and their function in prey carriage, generally in securing contact of the sting with the body of the victim.

Sting palpi are provided with receptory bristles that can also function in holding the body of the prey. The majority of sphecids that prey upon fast fliers (Diptera, Hymenoptera) have a curved stylet (Radovic 1985). The stylet of *S. relucens,* although it preys upon Diptera, is not extremely curved (compared to that in *Oxybelus* species), probably due to light prey preference. Numerous tubercles on the sides and edges of the stylet function in increasing the stylet surface that is in contact with the victim's internal tissues. As the lancet barbs are positioned dorsally, the sharp pointed stylet tip probably does not function in severing parts of the victim's tissues caught in the lancet barbs.

The function of lancets is anchoring the stylet in the body of the victim (Ondricek-Fallscheer 1992). We found no lancets in exserted position in all specimens examined, so we could not ascertain whether the lancets protrude beyond the tip of the stylet. Dorsally positioned barbs have a function in securing prey impaled on the sting (Radovic 1985).

Most of the listed structural modifications are correlated to complex behavior patterns of this species. Predatory insects that use their sting for prey carriage share several important advantages to those that use mandibles or legs. Positioning the prey in the back, wasps shift their gravitational center that is important in maintaining overall balance; this type of carriage permits rapid provisioning of the nest that positively affects the prey searching distance, provides fewer opportunities for predators and parasites to attack the prey, and leaves the mandibles and legs free for use otherwise (after Evans 1962).

Conclusions

There are three basic types of prey carriage in the family Sphecidae: mandibular, pedal and abdominal, each with several subtypes. The abdominal type of prey transport includes three subtypes one of which

is abdominal transport with the use of the sting, such as that found in *S. relucens.*

Using SEM we found the following in *S. relucens:* two sting palpi consisting of two segments with approximately ten receptory bristles distributed along the palpus tip that also function in securing prey impaled on the sting and the long and curved stylet with a sharp pointed tip, covered with tubercles which are different in shape and size, and provided with two lancet tracks; lancets, positioned on the ventral side of the stylet, and embedded in lancet tracks, are sharply pointed and covered with small tubercles, six barbs are found on the dorsal side of the lancets.

Most of the structural characteristics examined serve in securing firm contact of the sting with the body of the victim.

Acknowledgments

This research was supported by the Serbian Republic Fund for Science, project No. 03E04. We are also grateful to Dr. Ole Lomholdt for specimens used in this research.

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